



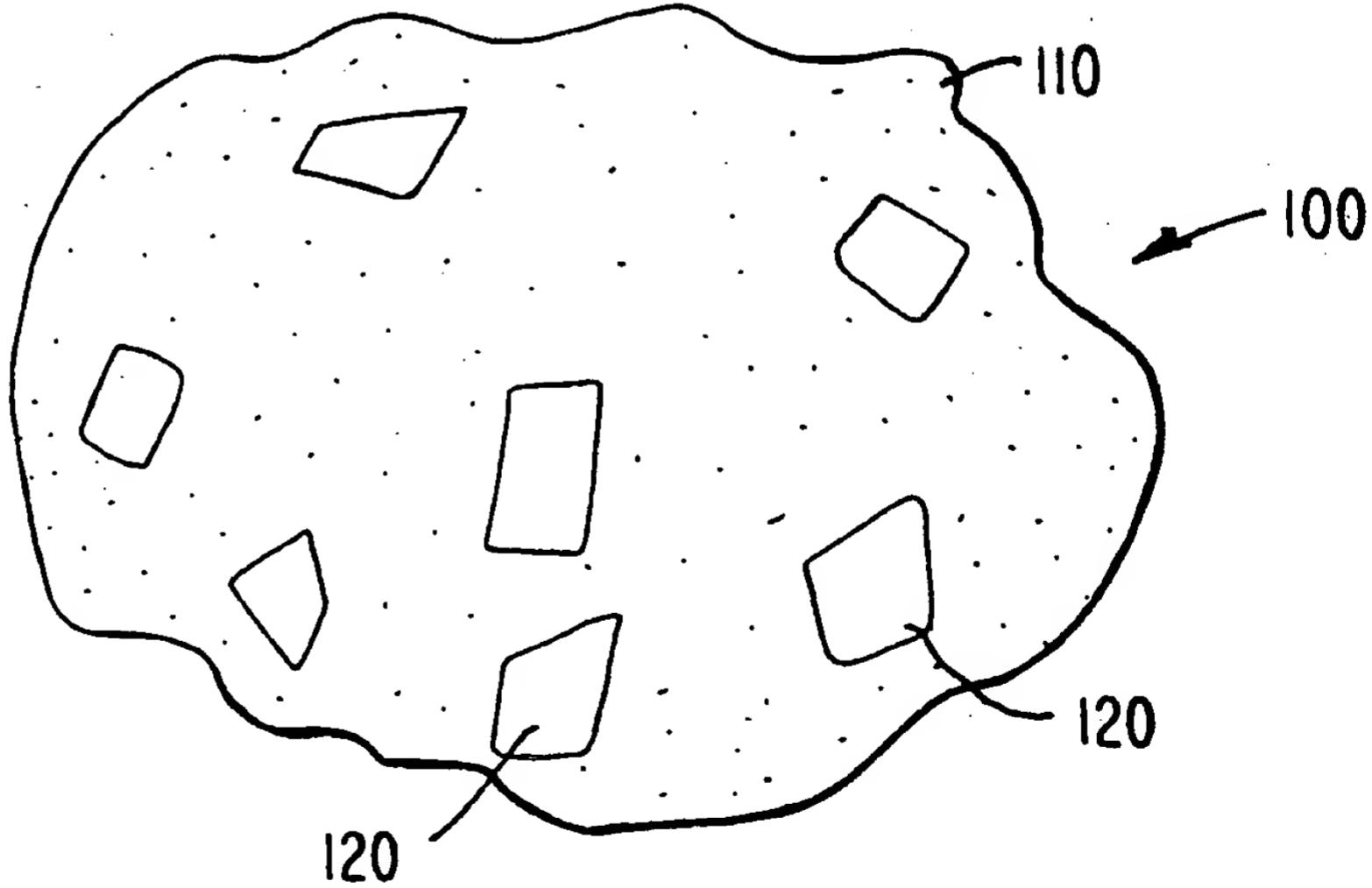
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Published*With international search report.**Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.***(54) Title:** APPARATUS FOR CLEANING OIL SPILLS AND METHOD THEREOF**(57) Abstract**

In accordance with the invention, a magnetic sorbent (100, 200, 300) for cleaning oil spills or the like is provided, including an absorbent material (110, 210, 310) and a magnetically attracted material (120, 220, 320) coupled with the absorbent material. The absorbent material may be formed of a conventional sorbent material, or may be formed of a recyclable material. Also provided in accordance with the invention is a method of cleaning up an oil spill or the like comprising the steps of placing a magnetic sorbent in contact with said oil so that said magnetic sorbent absorbs the oil and attracting said magnetic sorbent by the use of a magnet. The magnet may include a hand held unit, a magnetized boom (450), or any other sufficiently strong magnet.



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APPARATUS FOR CLEANING OIL SPILLS AND METHOD THEREOF

BACKGROUND OF THE INVENTION

5 This invention relates generally to an apparatus and a method utilizing this apparatus for cleaning up oil spills, and more particularly to an improved apparatus and method for cleaning oil spills which is easier to use, and is more efficient than traditional cleanup schemes.

Oil spills from oil tankers or other oil holding or pumping apparatus in
10 the ocean or other bodies of water is a great environmental problem. Any oil spill can
destroy the natural habitat of any number of animals, plants, and any other living
things in an ecosystem. The visions of this destruction are made all to real when oil-
covered birds and other water animals are shown dying on the beach after an oil spill
has happened. Because of this potentially devastating effect an oil spill can have on
15 the environment, it is crucial that any oil spill be contained and recovered so that it
cannot affect any of the local ecosystem, and that the oil spill be quickly cleaned up so
that the spilled oil has no chance of escaping.

Since oil has a lower specific gravity than water, any oil from an oil spill
will remain on top of the water surface. Additionally, because the oil remains on top
20 of the water and the water in such a body will remain at a constant level, the oil will
continue to spread out, forming an ever expanding oil slick. In this manner, spilled oil
can travel great distances from the point of the spill, being carried by ocean currents,
wind, or other forces acting upon the water. Thus, in order to contain such an oil spill,
traditionally, a boom is placed around the oil spill. This boom is a floating closed loop
25 which primarily floats on the top of the water, and may have a short hanging portion
which extends a bit below the surface of the water. Such booms are sold by any
number of companies, including 3M, Bixby International, and Oil Stop, Inc., for
example. Since this is a closed loop, and since oil floats on top of water, such an
apparatus can retain an oil slick. However, this boom does not aid in the actual
30 removal and recovery of the oil. Additionally, this boom can only be used if the spill

is caught early. If the oil has already begun to spread, it would be very difficult to place a boom around the oil. Finally, such a boom is necessarily made up of a plurality of interconnected segments so that the boom can conform to any required shape, and can maintain its position floating on top of the water even if the water's 5 surface is uneven as a result of waves, surges or other disturbances. Oil may escape between these segments.

When an oil spill is retained within a boom, there are a number of traditional methods for removing the oil. The first involves the use of a skimmer. The skimmer is similar to a vacuum, and is run over the top of the water surface suctioning 10 the oil from the surface, and placing it into another vessel. Such skimmers are sold by any number of companies, including Aqua-Guard, Hyde Products, Inc. and Vikoma, for example. While this method is often used during conventional cleanups, it is very difficult to ensure that all of the oil has been lifted from the surface of the water. Additionally, if a large amount of oil has been spilled, because the skimmer can only 15 work in a single location at once, even if a number of skimmers were used, much of the oil would be sitting in the water for an extended period of time. This increases the chance that some of the oil may escape, resulting in any number of the environmental problems noted above.

A second method for cleaning an oil spill, whether retained within a 20 boom or not, is to treat the oil with a solvent which breaks down the oil. The slick is broken up by the solvent, the oil is broken into very small parts, and simply is carried away by the water. Such solvents are sold by any number of companies, including Chemitreat, Petrotech and Nalco/Exxon Energy Chemicals, L.P., for example. While this breaking up of the oil may alleviate the immediate danger to a particular area, the 25 oil is spread throughout the water, and will still have some detrimental effects to the area. Additionally, none of the oil is recovered. Furthermore, this method may only work when a spill occurs in an open area. If such a spill occurs too close to a shoreline, the oil may still accumulate on the shore.

A third method for cleaning up an oil spill, whether retained in a boom or not, is to utilize a material called a sorbent. This material acts like a sponge, soaking up the spilled oil. Thus, if an oil spill is retained within a boom, the sorbent material would be dumped into the spill and would soak up the oil. Then, it would still be necessary to use a skimmer type instrument to remove the saturated sorbent from within the boom. However, because the oil is retained within the sorbent, there is less chance of the oil escaping. Such sorbents are sold by any number of companies, including 3M, Matarah Industries, Inc. and Unitor Enviro Team, Inc., for example. Additionally, if the oil is not retained within a boom, it is necessary to spread this sorbent material over a wide area. It would then be difficult to collect all of the oil-laden sorbent. Furthermore, when the oil has spread, it is beneficial to use a sorbent with smaller pieces of material, so that there is additional surface area for collection of oil, and so that the material can spread out better. This will allow for better protection of a shoreline from an approaching oil slick, for example. However, when the fine material soaks up the oil, it is spread out over a large area and is difficult to collect. Additionally, if this fine material reaches the shore, it may become coated on the shore and animals, also causing damage, and being very hard to pick up.

Therefore, it would be beneficial to provide an improved apparatus and method for cleaning oil spills which soaked up oil sufficiently, which was easy to collect after the oil had been soaked up and which better protects an ecosystem from environmental damage after an oil spill.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, an improved apparatus and method for cleaning oil spills is provided. The apparatus includes a sorbent material coupled with a material which is attracted by a magnetic field to form a magnetic sorbent. The sorbent may be in the form of small pads, shredded sorbent material, or even recycled cardboard, newspaper, paper sawdust or the like. In each embodiment of the invention, a small amount of magnetically attracted material is

coupled with the absorbing material. This material is then used as would any other sorbent, as noted above to soak up the oil.

When the sorbent has soaked up the oil spill, it is possible to collect the
5 saturated sorbent simply by generating a magnetic field. The attractive material
coupled to the sorbent will be attracted to the magnetic field, and the sorbent can be
removed from the water in this area. Such a magnet could be employed in a ship, in a
boom surrounding an oil spill, or even in a hand held unit. Thus, depending on where
the sorbent had traveled, a magnet could be utilized to recover the oil.

10 The magnetic sorbent can be manufactured in any number of ways.
First, it is possible to manufacture sorbent from a mixture including small
magnetically attracted particles. Thus, when the pads are extruded and formed, the
magnetically attracted particles would be an integral part of the structure of the
sorbent. If shredded material is formed into the collecting material, the magnetically
15 attracted particles would similarly be integrally formed as an integral part of the
structure of the sorbent. Alternatively, sorbent pads or other structure may be formed,
and metallic strips or other structures may be adhered thereto. Additionally, it would
be possible to mix the sorbent and small magnetically attracted particles with a glue, to
adhere the particles to the sorbent. This is an especially beneficial method when the
20 sorbent being used includes recycled newspaper, cardboard, sawdust or the like.
When this type of sorbent is used, it is further possible to use the saturated sorbent as a
fuel, since after use, the oil will be retained in a burnable, medium.

Accordingly, it is an object of the invention to provide an improved
apparatus and method for cleaning up oil spills.

25 Another object of the invention is to provide an improved apparatus and
method for cleaning up oil spills in which the collection of the spilled oil is performed
more easily.

A further object of the invention is to provide an improved apparatus
and method for cleaning up oil spills in which both contained and uncontained spills

may be cleaned up more efficiently, resulting in a reduction in the environmental damage caused thereby.

Yet another object of the invention is to provide an improved apparatus and method for cleaning up oil spills in which the recovered oil may be reused.

5 Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

10 The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings in which:

15 FIG. 1 is a perspective view of a portion of magnetic sorbent constructed in accordance with a first embodiment of the invention;

FIG. 2 is a top plan view of a portion of a magnetic sorbent constructed in accordance with a second embodiment of the invention;

20 FIG. 3 is a top plan view of a portion of a magnetic sorbent constructed in accordance with a third embodiment of the invention;

FIG. 4 is a top plan view of an oil spill cleanup apparatus constructed in accordance with the invention;

FIG. 5 is a flowchart depicting the construction of a magnetic sorbent in accordance with the invention;

25 FIG. 6 is a flowchart depicting the construction of a magnetic sorbent in accordance with an alternative embodiment of the invention; and

FIG. 7 is a flowchart depicting the construction of a magnetic sorbent in accordance with an additional embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is first made to FIG. 1, which depicts a magnetic sorbent constructed in accordance with a first embodiment of the invention. A magnetic sorbent 100 is formed of an absorbing material 110 and one or more magnetically attracted (having the property of being attracted by a magnet) particles 120. Absorbing material 110 may comprise any known sorbent conventionally used for the absorption of oil. In a preferred embodiment, absorbing material 110 may be a mixture of recycled material, including but not limited to newspaper, paper, cardboard, sawdust or the like. Additionally, in a preferred embodiment, magnetically attracted particles 120 may be formed of food grade iron. Furthermore, while this description includes the use of magnetically attracted particles, it would be equally possible to include particles which were attracted to any particular attracting mechanism. Thus, in this embodiment a portion of magnetic sorbent is formed of an absorbing portion and an attracted portion, the attracted portion still allowing sufficient surface area of the absorbing material to absorb oil or other spilled material. In a preferred embodiment, since the sorbent is formed of a combustible material, it would be possible to use the oil soaked sorbent as fuel.

The method of forming such a magnetic sorbent is depicted in FIG. 5. Specifically, first, an adhesive is mixed with water or other appropriate liquid and is then heated in step 150. Then, in step 152, the adhesive and water mixture is added to a sorbent such as a paper based product, sawdust or the like. Next, a number of magnetically attracted particles are added to the mixture in step 153 so that the magnetically attracted particles adhere to the sorbent. Finally, in step 154, the mixture is dried so that the material comprises any number of individual magnetic sorbents 100. In a preferred embodiment the sorbent may be formed of a recycled material or sawdust. The recycled material may also be recyclable in the future. The attracted particles may be finely powdered Iron or the like. Because the attracted particles are so fine they leave a sufficient amount of sorbent surface area exposed to absorb the

oil. Thus, in this manner, a magnetically attracted sorbent formed of recycled material may be formed.

FIG. 2 depicts a magnetic sorbent constructed in accordance with a second embodiment of the invention. In FIG. 2, a magnetic sorbent 200 comprises an absorbing material 210 and one or more magnetically attracted particles 220. In this case, the absorbing material is formed into a sheet, and is then cut into individual pieces. While FIG. 2 depicts a square absorbing material, any shape may be utilized, including the irregular shredded shape of FIG. 1. While the materials used to construct magnetic sorbent 200 may be the same as those in FIG. 1, it is more likely that magnetic sorbent 200 will be formed of more conventional sorbent material, with magnetically attracted particles 220 being added to the material before it is formed into the individual pieces. Thus, as the material is extruded, or otherwise formed into a sheet or the like, magnetically attracted particles 220 will already be imbedded in the sorbent material. The formation of this material will allow the use of conventional extrusion machines, or other conventional sorbent production machines, thus reducing the startup cost associated with the practice of the invention. Since the sorbent may be formed of a rubber material, such as a sponge, it would be possible to collect the pieces and remove the oil from them, by centrifuge or by the application of pressure. Thus, the recovered oil could be used for fuel, and the magnetic sorbent could be reused during a future cleanup operation.

FIG. 6 depicts a method for forming magnetic sorbent 200. First, in step 251, a molten sorbent is formed in a conventional manner. This molten sorbent may be formed by the addition of heat, or by chemical or other methods of forming a liquid sorbent, as is known in the art. Next, in step 252, at least one magnetically attracted particle 220 is added to the molten sorbent, thus forming a sorbent/magnetic particle mixture. Finally, the molten sorbent is formed into the shape of a conventional sorbent such as the sheet in FIG. 2, in step 253. This sorbent may be formed as that shown in FIG. 2, in which the sorbent would be formed into a long sheet and then cut into any number of pieces. Alternatively, it would be possible to extrude any number

of particles with a shape as shown in FIG. 1, where absorbent material 110 would be a conventional sorbent rather than recycled material.

FIG. 3 depicts a magnetic sorbent constructed in accordance with a third embodiment of the invention. In FIG. 3, a magnetic sorbent 300 is formed of an absorbing material 310 and a magnetically attracted material 320. In this embodiment, the absorbing material 310 is formed as a conventional sorbent, and then magnetic material 320 is coated over one portion of absorbing material 310. While FIG. 3 depicts a square piece of magnetic sorbent 300, it is possible to use strips thereof to increase the available surface area of the absorbing material.

FIG. 7 depicts the method employed in the formation of magnetic sorbent 300. As is shown in FIG. 7, in step 351, a molten sorbent is formed, as noted above in FIG. 6, and a conventional sorbent structure is formed in step 352. Then, in step 353, a magnetically attracted material is coated on a portion of the conventional sorbent structure to leave sufficient surface of the sorbent exposed. In this manner, the conventional sorbent will be rendered magnetically attractive. Also, this method does not require that any magnetically attracted particles be added to the molten sorbent prior to formation. Since the magnetically attracted material is fixed to only a portion of the conventional sorbent, the sorbent will still retain its absorptive properties. Thus, it is possible to provide a magnetic sorbent by adhering magnetically attracted material to conventional or other sorbents in any manner, so long as the magnetically attracted material is sufficiently attached to the sorbent to allow the magnetic sorbent as a whole to be attracted magnetically.

Reference is next made to FIG. 4, which depicts an oil spill cleanup apparatus constructed in accordance with the invention. As is shown in FIG. 4, an oil spill cleanup apparatus 400 further comprises a base 440. Because most oil spills occur on water based 440 may be a ship, oil platform, or other structure. A magnetic boom 450 is attached to base 440 at two points 441 and 442, and therefore forms an enclosure, consisting of boom 450 and structure 440. Boom 450 encircles magnetic sorbent 410 applied to spilled oil 430. Magnetic sorbent 410 may include magnetic

sorbents 100, 200, 300 or the like, as described above. Magnetic sorbent 410 will soak up oil 430, since magnetic sorbent 410 may be formed in part of a material which soaks up all liquid, or alternatively may be formed in part of a material which soaks up all liquid other than water as is known in the art. Thus, oil 430 will be absorbed within 5 sorbent 410. Then, a magnetic field is generated in boom 450, thereby attracting the individual portions of magnetic sorbent 410 to boom 450. Magnetic sorbent 410 will move in the direction of arrows A in FIG. 4, towards boom 450. By attracting magnetic sorbent 410 to boom 450, the cleanup of magnetic sorbent 410 is greatly simplified, since it is possible to now pass a stronger magnet over boom 450, thereby 10 attracting the oil soaked particles of magnetic sorbent 410 out of the water. Alternatively, magnetic boom 450 could be turned off prior to the final collection of magnetic sorbent 410. Thus, no conventional skimmer or other collecting device is required.

An additional benefit of this scheme is that any portions of magnetic 15 sorbent 410 which might escape outside of boom 450 would also be attracted to the outside of boom 450. Thus, this scheme aids in containing the spilled oil, in addition to aiding in its cleanup. While FIG. 4 depicts and contemplates a base 440 such as a ship, it is only necessary for a structure able to generate a sufficient magnetic field in 20 boom 450. Thus, it would be possible to provide an independent boom having a contained generator or other structure 440 to generate a magnetic field in boom 450 which could be placed in a location which a ship or the like could not reach.

The preferred employment of the invention utilizes boom 450. However, even without a magnetized boom, or any sort of boom, the magnetic sorbent 25 of the invention may still be used effectively. Specifically, the oil soaked magnetic sorbent may be recovered by a magnet placed near the water surface. Therefore, a trolling boat could recover the spill without a boom, if one were not available. Further, if an oil spill is approaching a shoreline it is possible to sprinkle an effective amount of magnetic sorbent along the shoreline to soak up any oil which approaches. Then, if the magnetic sorbent washes up onto the shore, it would be possible to pick up

this magnetic sorbent by passing a magnet over the material on the shore. This could be performed with a hand held unit. Thus, whereas when conventional sorbents are used, it is still necessary to have someone pick up each piece of sorbent if it were to wash onto the shore because conventional skimmers cannot be used, with magnetic 5 sorbent, the job is easily and cleanly accomplished. If the magnetic sorbent were not washed up on shore, it could be easily collected by a hand held or floating apparatus which generates a magnetic field sufficient to attract the magnetic sorbent.

If a portion of the magnetic sorbent were to escape from the area where the magnetic field is cleaning up the magnetic sorbent, it would be possible to scan the 10 entire area at a later time with a magnetic field, thus attracting any stray magnetic sorbent particles. However, even if some of the magnetic sorbent were to escape permanently, either with or without oil, no great environmental danger would be posed, and certainly no greater than the danger posed by escaping oil, or conventional sorbents. Specifically, if a biodegradable sorbent is used, such as recycled paper 15 products, or any other biodegradable sorbent, after some time, the sorbent will break down, and any associated iron particles will fall of the floor of the body of water. Since the material will likely be iron, it will perhaps act as a fertilizer, and in any event will not greatly effect the ecosystem. Any small amount of oil will similarly be dissipated by the water. While the escape of any oil is undesirable, the present 20 invention reduces the harm to the environment by allowing more oil to be collected faster, and also by reducing the potential damage to the environment if any oil does escape.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain 25 changes may be made in carrying out the above method and in the constructions set forth without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall there between.

What Is Claimed:

1. A magnetic sorbent, including:
an absorbent material; and
a magnetically attracted material coupled with said absorbent material.
2. The magnetic sorbent of claim 1, wherein said absorbent material comprises a paper based material.
3. The magnetic sorbent of claim 1, wherein said absorbent material comprises cardboard.
4. The magnetic sorbent of claim 1, wherein said absorbent material comprises recycled material.
5. The magnetic sorbent of claim 1, wherein said absorbent material comprises a newspaper.
6. The magnetic sorbent of claim 1, wherein said absorbent material comprises sawdust.
7. The magnetic sorbent of claim 1, wherein said magnetically attracted material comprises iron.
8. The magnetic sorbent of claim 7, wherein said iron is food grade iron particles.
9. The magnetic sorbent of claim 7, wherein said iron comprises strips of iron.

10. The magnetic sorbent of claim 1, wherein said magnetically attracted material is fixed to said absorbent material by adhesive.
11. The magnetic sorbent of claim 1, wherein said magnetically attracted material is integrally formed with said absorbent material.
12. The magnetic sorbent of claim 1, wherein said magnetic sorbent is adapted to be utilized as fuel after use.
13. The magnetic sorbent of claim 1, wherein said absorbent material is recyclable.
14. A method of forming a magnetic sorbent, comprising the steps of:
mixing an adhesive with water to form an adhesive and water mixture;
adding said adhesive and water mixture to an absorbent material;
adding magnetically attracted particles to said mixture; and
drying said mixture, whereby said magnetically attracted particles are fixed to said absorbent material by said adhesive.
15. The method of claim 14, further comprising the step of heating said adhesive and water mixture prior to adding said mixture to said absorbent material.
16. The method of claim 14, where said absorbent material comprises a paper based product.
17. The method of claim 14, wherein said absorbent material comprises cardboard.

18. The method of claim 14, wherein said absorbent material comprises sawdust.

19. The method of claim 14, wherein said absorbent material is recyclable.

20. The method of claim 14, whereby said magnetic sorbent may be utilized as fuel after use.

21. A method of forming a magnetic sorbent, comprising the steps of:
forming a molten sorbent;
adding magnetically attracted particles to said sorbent to form a mixture; and
forming a sorbent from said mixture of molten sorbent and magnetically attracted particles.

22. The method of claim 21, further comprising the step of removing oil from said magnetic sorbent after use, so that said magnetic sorbent may be reused.

23. A method of forming a magnetic sorbent, including the steps of:
forming a sorbent; and
fixing a magnetically attracted material to said sorbent.

24. The method of claim 23, wherein said magnetically attracted material is formed into strips prior to being fixed to said sorbent.

25. A cleanup apparatus for cleaning up an oil or other chemical spill, comprising:
a magnetic sorbent; and
a selectively magnetized boom.

26. The cleanup apparatus of claim 25, wherein said boom is placed around an oil spill, and said magnetic sorbent is magnetically attracted thereto.
27. A method of cleaning up an oil spill, comprising the steps of:
 - placing a magnetic sorbent in contact with said oil so that said magnetic sorbent absorbs the oil; and
 - attracting said magnetic sorbent by the use of a magnet.
28. The method of claim 27, further comprising the step of placing a selectively magnetized boom around the oil spill, whereby said magnetic sorbent is magnetically attracted thereto.
29. The method of claim 27, wherein said magnet is a hand held magnet.
30. The method of claim 27, wherein said magnet attracts said magnetic sorbent from water.
31. The method of claim 27, wherein said magnet attracts said magnetic sorbent from a shoreline.

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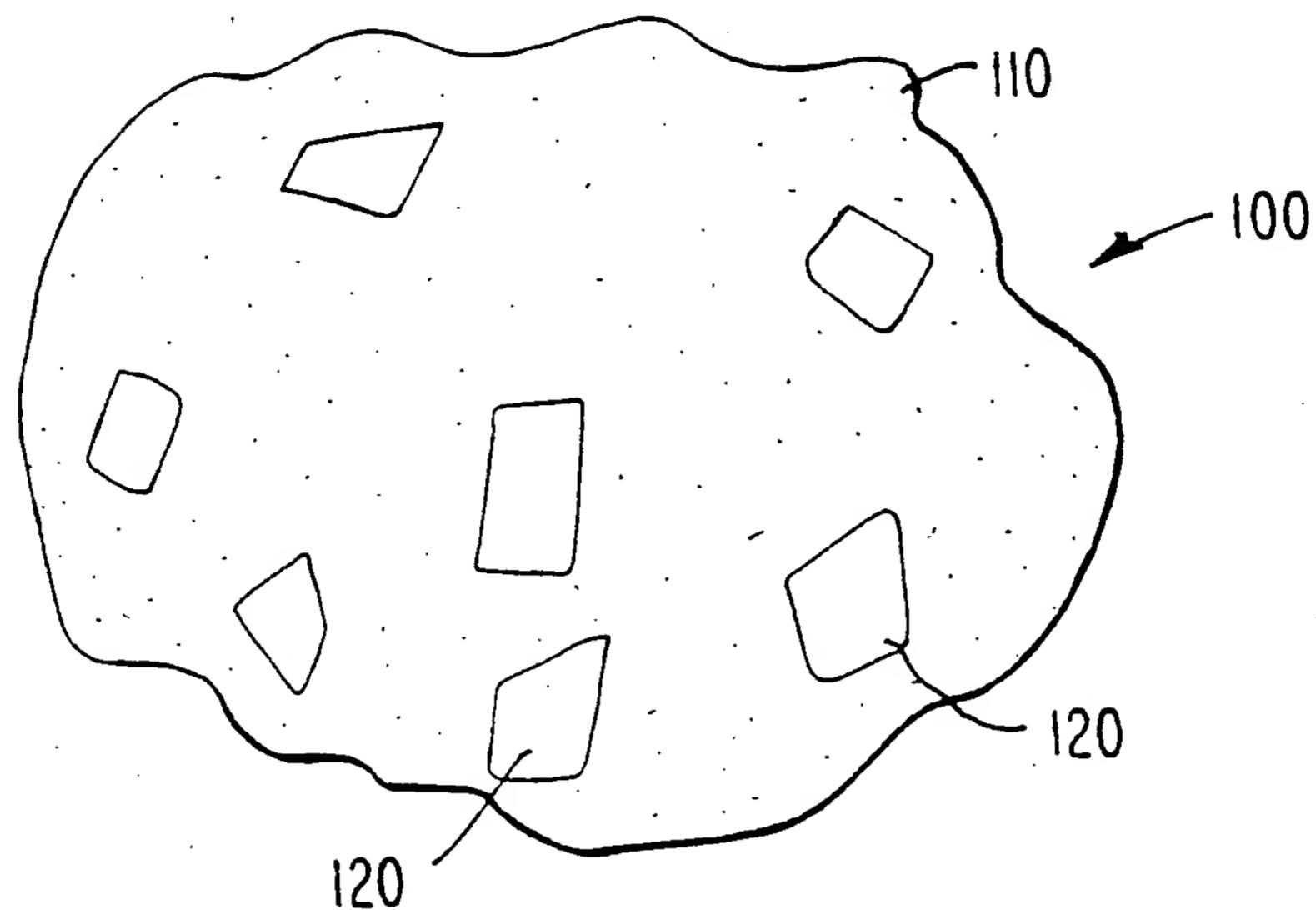
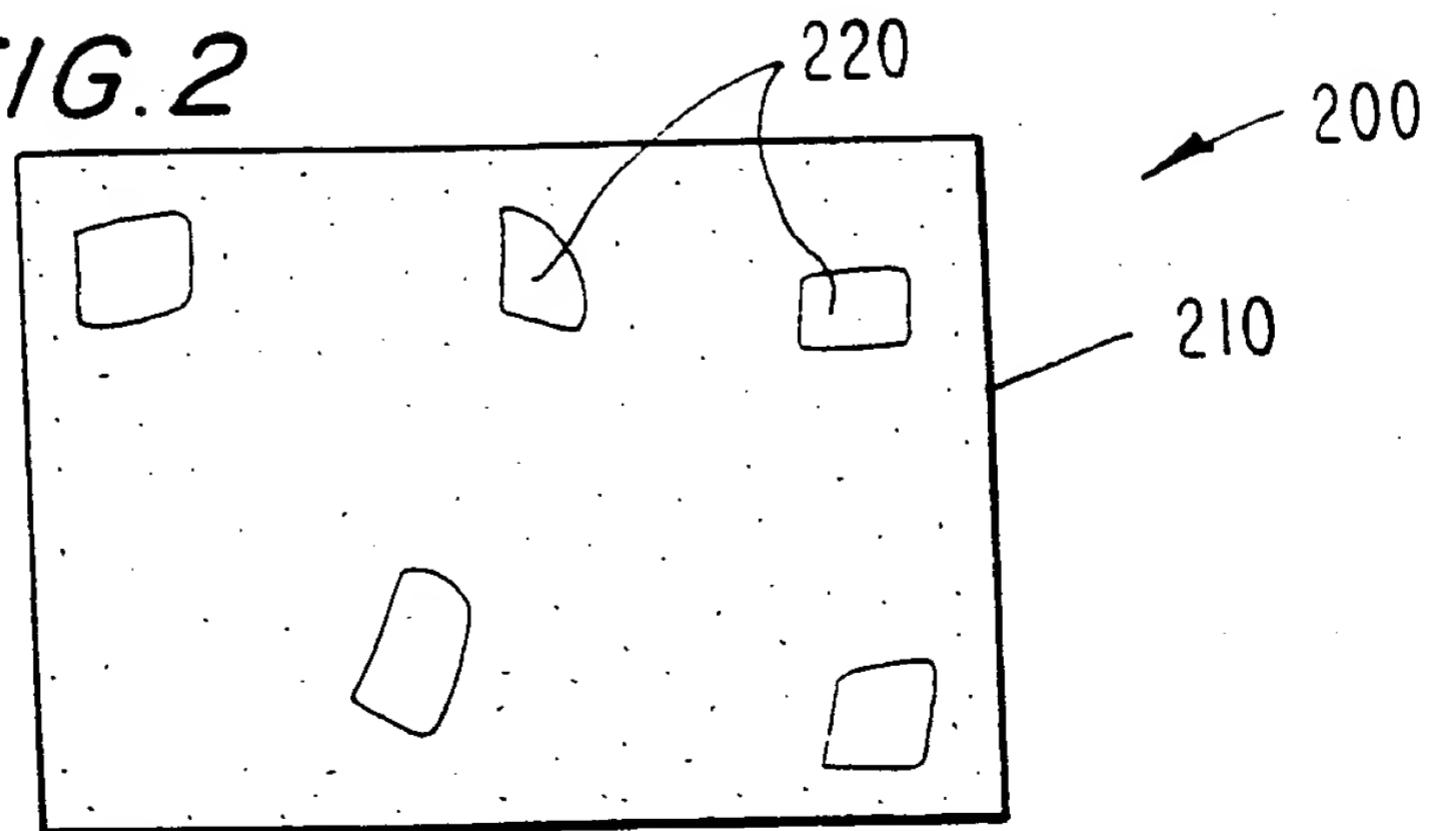


FIG. 1

FIG. 2



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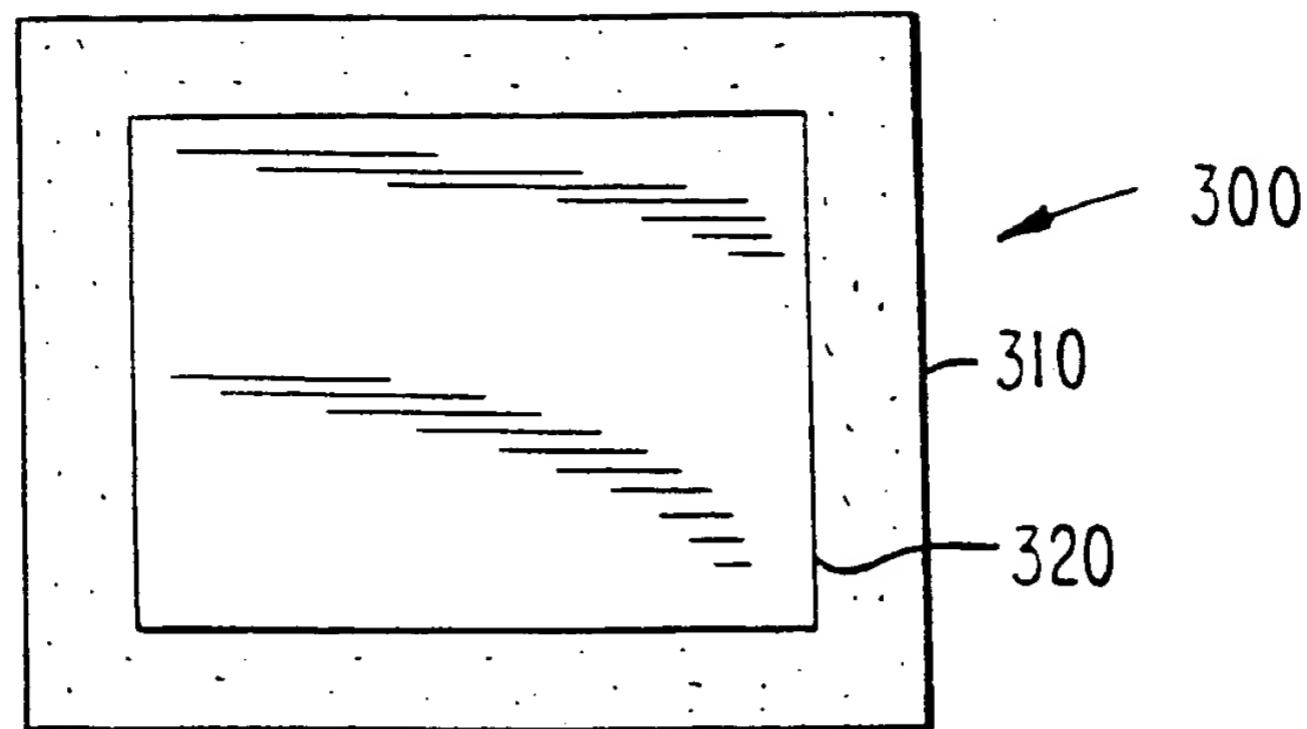


FIG. 3

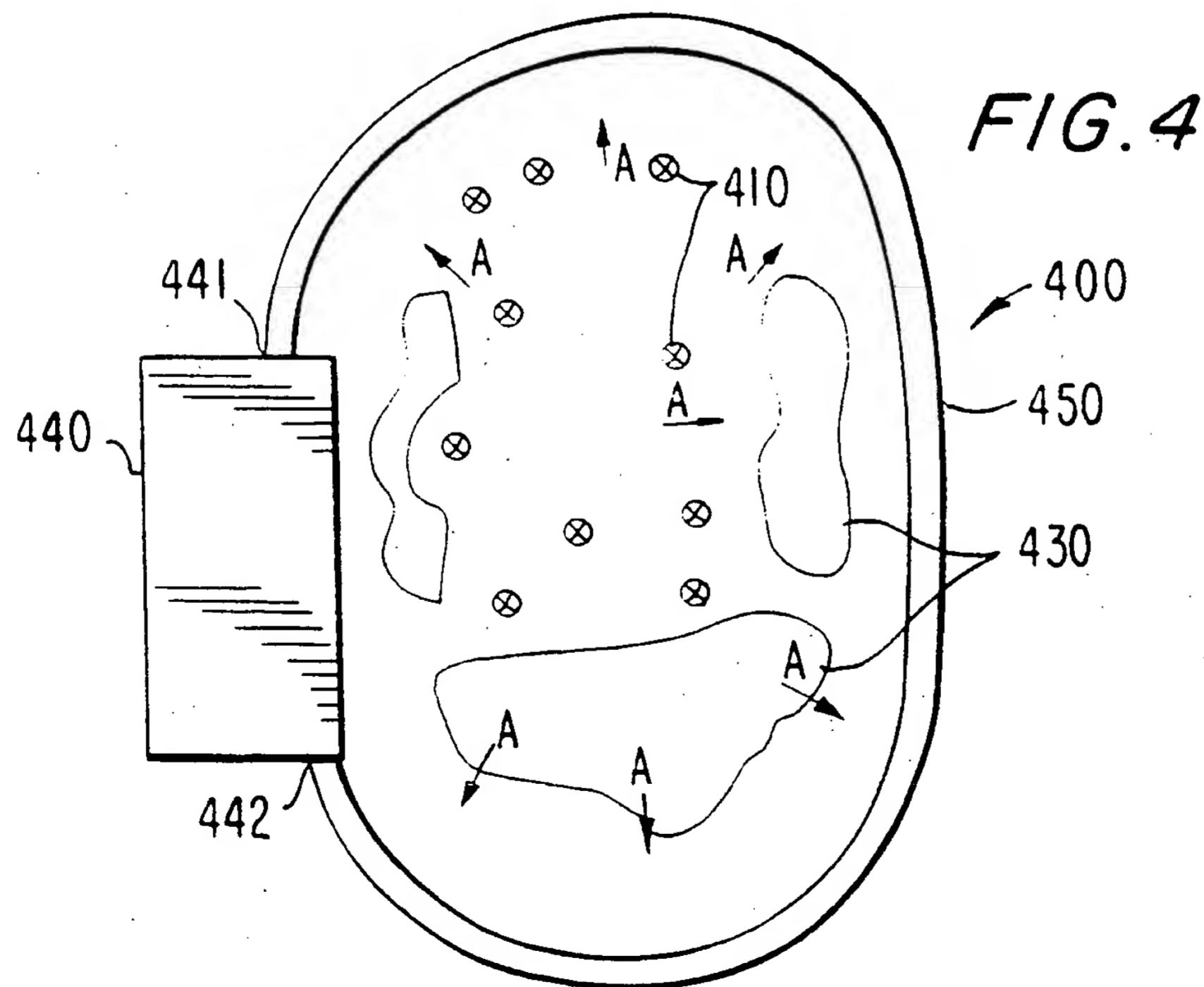


FIG. 4

3/4

150

HEATING ADHESIVE
AND WATER
MIXTURE

FIG. 5

152
ADDING ADHESIVE
AND WATER MIXTURE
TO ABSORBENT MATERIAL

153
ADDING MAGNETICALLY
ATTRACTED
PARTICLES

152

153

154

DRYING

251

FORMING A MOLTEN
SORBENT

FIG. 6

252
ADDING MAGNETICALLY
ATTRACTED PARTICLES

253
FORMING A SORBENT
STRUCTURE FROM THE
MOLTEN SORBENT

4 / 4

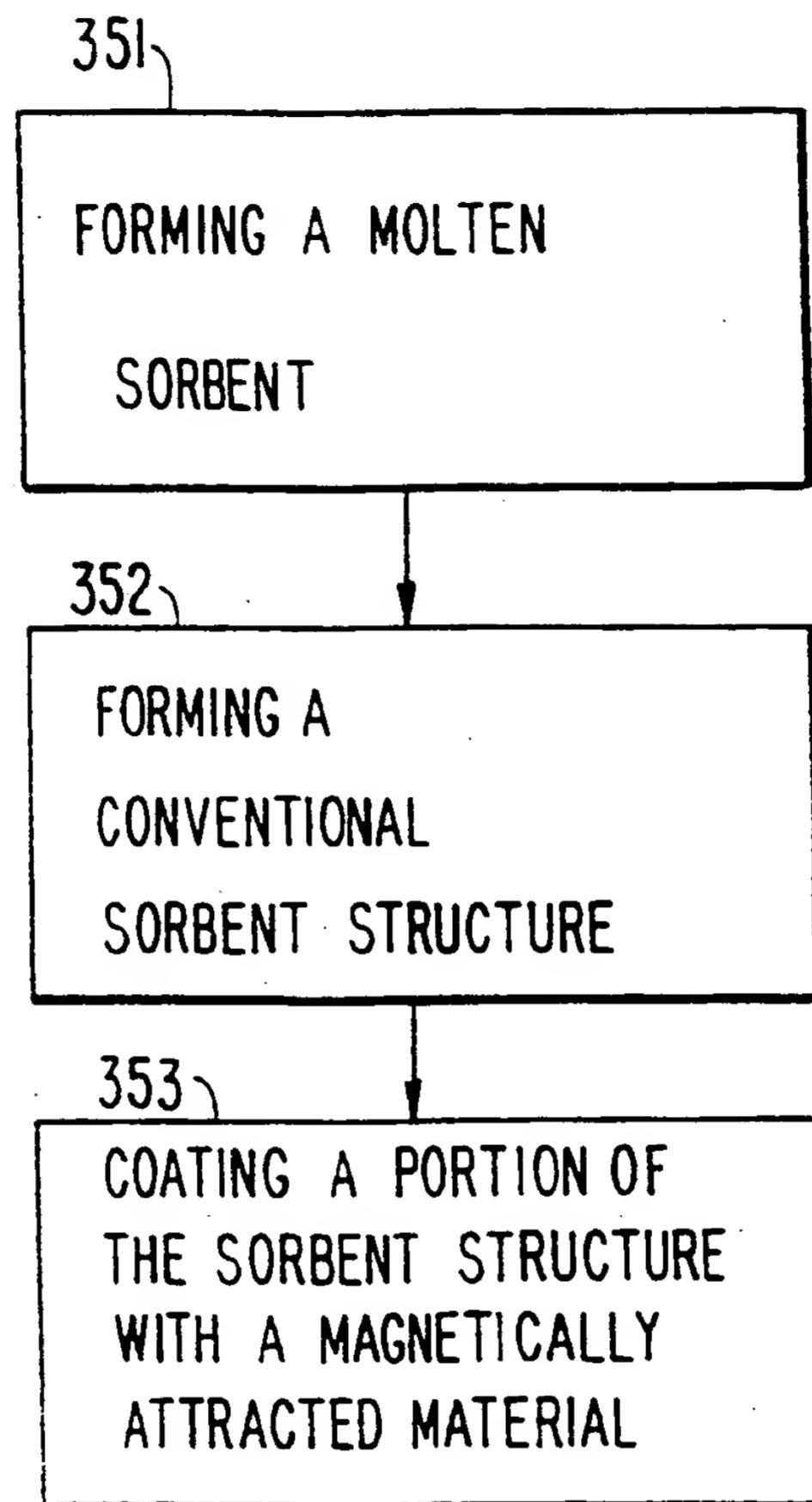


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US98/11103

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B01D 15/00; B01J 20/02; C02F 1/28; E02B 15/10
 US CL : 210/671, 680, 691, 242.4, 924; 427/128; 428/464, 900; 502/406

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 210/671, 680, 691, 242.4, 924; 427/127, 128; 428/464, 900; 502/406

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,187,187 A (TURBEVILLE) 05 February 1980, entire document.	1, 7, 10-12, 13, 23, 25-27 and 30
Y		----- 2-6, 8, 9, 14-22, 24-27, 29 and 31
X	US 3,890,224 A (WEISS et al) 17 June 1975, col. 7, lines 17-18.	25-28 and 30
Y	US 3,607,741 A (SOHNIOUS) 21 September 1971, entire document.	2-6 and 16-18

 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

18 AUGUST 1998

Date of mailing of the international search report

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